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Otto Sandin

Assessment of the Effectiveness of *Bacillus thuringiensis* Berliner in Controlling the Great Basin Tent Caterpillar

Bryce Canyon National Park

Utah

By

R. I. Washburn

Entomologist

Division of Timber Management

U. S. Forest Service

Ogden, Utah

Introduction

For many years the National Parks in Southern Utah have been plagued with periodic outbreaks of the Great Basin tent caterpillar, Malacosoma fragile (Stretch). The outbreaks generally have built up to epidemic proportions, nearly simultaneously, throughout the southern third of the State, remained at a high level for five to seven years, and then returned to endemic conditions. Periods when the populations have been at a low level have ranged from three to five years. During epidemics the caterpillars usually destroy from 70 to 100 percent of the foliage on deciduous plants each year. While the trees and shrubs usually refoliate later in the summer, this type of damage is highly undesirable in high-use recreation areas. The destruction of foliage affects the shade in campgrounds, seriously affects the aesthetics, and weakens the host plants. In addition the caterpillars are a considerable annoyance to the tourists.

Control efforts have been carried on against this pest in Zion and Bryce Canyon National Parks for at least the last fifteen years. During this period the National Park Service has worked constantly toward improvement of the control effort through more efficient methods of application and more suitable insecticides.

In 1959 field tests showed Bacillus thuringiensis Berliner would effectively kill the Great Basin tent caterpillar. 1/ Since 1961 Zion National Park has used Bacillus thuringiensis successfully as the toxicant against the Great Basin tent caterpillar infesting primarily Fremont cottonwood.

Bacillus thuringiensis was used in Bryce Canyon National Park for the first time in 1964. The objective of the control program was to reduce an epidemic population of Great Basin tent caterpillar infesting bitterbrush along scenic drives and viewpoints. The purpose of this report is to discuss the results of this suppressive action.

Methods

Thuricide 90 T flowable containing 30 billion viable spores of Bacillus thuringiensis Berliner per gram was used as the controllant. Mixed with water, it was sprayed from a truck-mounted Buffalo turbine mist blower. The formulation and rate of delivery were calculated to apply approximately two pounds of active ingredient per acre, except in a small test area where the approximate equivalent of one pound of actual per acre was applied. The spraying was conducted in the early morning hours June 1 through June 5. Second and third instar larvae were prevalent in the sprayed areas at the time.

Immediately after spraying a number of branches each containing a colony of caterpillars were collected at random from selected infested

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1/ Knopf, J. A. E., Preliminary Tests of Bacillus thuringiensis Berliner on Great Basin Tent Caterpillars Progress Report, U. S. D. A., Intermountain Forest and Range Experiment Station, 1960.

brushes, along with a supply of foliage. Nine samples were taken from the area sprayed with the two-pound dosage, seven samples from the one-pound areas, and two from a nonsprayed infested area, to serve as checks. The samples were placed in individual gallon jars, capped, and shipped by air to the Division of Timber Management insect laboratory in Ogden, Utah.

In the laboratory, caterpillars were reared at room temperature averaging 72° F. day and 60° F. night, with a normal day length. The first mortality count was made six days after treatment June 8, and succeeding counts were made periodically thereafter through June 16.

The bitterbrush infested in Bryce Canyon National Park is a low growing shrub, rarely exceeding two feet in height, with many of the branches running along the ground. The caterpillars, when feeding on bitterbrush, rest in their tents, but feed out beyond the tents often traveling several branches from the tents. Therefore, recovery of dead caterpillars appeared impractical. To make accurate counts in the field would have required disruption of the host plants, thus, upsetting the microenvironment. Analysis of the results in the field was limited to relative abundance of the caterpillar population within and outside of the sprayed areas.

Observations of the larval population in the field were made by entomologists daily June 1 through June 11. Thereafter, National Park Service personnel made periodic checks. On June 26 the final field observation was made by an entomologist.

Results

In the laboratory the field sprayed larvae stopped feeding approximately 24 hours after having been sprayed. Six days after spraying 79 percent of the larvae sprayed with a two-pound dosage were dead; but, only 62 percent of the larvae treated with the one-pound dosage had died. The cumulative larvae mortality for both dosages increased steadily, and by the end of 14 days 100 percent were dead in the two-pound dosage, and 91 percent in the one-pound dosage (Table 1). While no statistical tests were run, there appears to be a relationship between larval density and mortality obtained by the one-pound dosage. In table 2 data are arranged by number of larvae per rearing jar, and the table shows that where larval population was less than 45, mortality for the first two observations was lower than the average for the observation. No such relationship seemed to exist for the larvae treated with the two-pound dosage.

Table 1.---Results of laboratory rearing of larvae collected after receiving field application of Bacillus Thuringiensis
Cumulative mortality in percent

Date	Days After Treatment	Replications No. of larvae per replication in ( ) 1 (39)	2 (56)	3 (58)	4 (61)	5 (67)	6 (69)	7 (97)	8 (154)	9 (161)	Avg.
		Two-Pound Dosage (Percentage)									
6/8	6	92	86	78	74	82	72	77	76	74	79
6/9	7	95	98	90	84	90	81	88	94	84	91
6/12	10	95	100	97	100	99	97	99	100	100	99
6/16	14	100	100	100	100	100	100	100	100	100	100
		One-Pound Dosage (Percentage)									
		(23)	(25)	(45)	(50)	(72)	(77)	(129)			
6/8	6	27	30	53	64	97	26	78			62
6/9	7	32	43	73	96	99	34	96			76
6/12	10	91	74	100	100	100	79	99			94
6/16	14	100	84	100	100	100	100	99			99
				1 (78)		Checks		2 (129)			
6/16				3				32			21

Table 2.---Cumulative mortality of larvae treated with one-pound dosage

No. of Larvae Per Jar	Observation Dates 6/8	6/9	6/12
		Percentage	
23	27	32	91
25	30	43	74 94*
45	53 62*	73 76*	100
50	64	96	100
72	97	99	100
97	26	34	79
128	78	96	99

*Average mortality by observations all replications.

In the field a decrease in feeding activity of the treated tent caterpillars was noted approximately 24 hours after treatment. Feeding activity continued to decrease until all activity ceased about June 11. During this time little larval mortality had occurred. The first obvious decrease in caterpillar population began to appear sometime after June 20. By June 26, live caterpillars were rare within the treated areas. One spot of less than one acre did contain some live caterpillars, but evidence indicated this was the result of poor coverage. Live caterpillars were still abundant at that time in all nontreated areas examined.

Discussion and Conclusion

Bacillus thuringiensis, when effective against the target insect, in an ideal insecticide since it does not have an affect on other animals or plants. Bacillus thuringiensis is a stomach poison and must be ingested by the insect. Although the mechanism of action may be different for different insect species, the ingestion of a lethal dose usually results first in a gut paralysis causing the insect to discontinue feeding. Mortality may occur within 72 hours or be delayed for days. The reason for the delay in tent caterpillar mortality in this project cannot be explained. However, a discussion of conditions existing during the assessment of this project may shed some light on the subject.

Weather conditions the first 26 days of June 1964, (duration of the test) in Bryce Canyon National Park were far from ideal from the standpoint of insect activity. The average maximum and minimum temperatures were 67.1° and 34.5°. The extremes were 82° and 25°. Out of the 26, minimum temperatures were below freezing for 12 days, and for 11 days the maximum temperature did not reach 70° F. Only on the last three days did the maximum temperature reach 80° F. On one-half of the days the average mean temperature did not exceed 52° F. Tent caterpillars do not feed on cold days; therefore, it is possible that it took longer for the caterpillars to ingest a lethal dose of Bacillus thuringiensis.

It is quite possible the time interval between application and maximum caterpillar mortality would be shortened if weather conditions were more conducive to insect activity. It is reasonable to expect warmer weather during the month of June at Bryce Canyon National Park. In fact in June of 1963, the average maximum temperature was 82° F., and the average minimum was over 13° higher than in 1964. There were no days in June of 1963 with the minimum below freezing, and the maximum temperature was above 70° for each day of the month.

Maximum mortality of the insects reared in the laboratory, where maximum and minimum temperatures were higher and less variable, occurred 12 days earlier than in the field. However, a definite conclusion cannot be made by comparing field and laboratory temperatures since in the laboratory rearing the insects were confined.

Even though it took approximately 18 to 24 days to obtain maximum mortality, the caterpillars did not feed more than a few days after treatment. Therefore, defoliation probably was not much more than that which would have occurred had the caterpillars been killed shortly after treatment.

The assessment of the Bryce Canyon control project shows that Bacillus thuringiensis was effective against the Great Basin tent caterpillar feeding on bitterbrush. It is reasonable to expect similar results can be obtained in future control projects providing formulation and other conditions are similar to those of the 1964 project.